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Administrative Report

PLANKTON COMMITTEE

by

G. Hempel

1976

Belgium

(R. de Clerck & L. de Coninck)

The study on the distribution in space and the evolution in time of fish eggs and larvae was continued during 1976. The sampling took place from March till May by means of the Dutch type Gulf Sampler. As already mentioned in previous reports, this study showed a domination of eggs and larvae of sprat (Sprattus sprattus). The second most important species was sole (Solea solea), however in much smaller numbers than sprat.

Canada

(T. Platt)

Theoretical studies have been made of the structure of pelagic food chains in the sea (Marine Ecology Laboratory). A general time-dependent model has been developed, based on accepted relationships for the weight-dependence of metabolism and growth. The general solution has been found. In the steady-state, the total biomass in any given size-class decreases in a regular manner with increasing size. The results are testable by direct measurement.

The classical explanation of the enhanced productivity of continental shelves is that they are greatly enriched by fresh water runoff. This explanation has recently been subject to reconsideration (Dalhousie University). A series of cruises has been run for two years on the Scotian Shelf to examine the various pathways of nutrient enrichment and recycling. These cruises show that on the average the outer 50 miles of a 160 mile transect from Halifax to slope water is at least twice as productive as the inner 100 miles. This region of higher productivity usually coincides with the location of a front between coastal water and slope water where vertical transport of high nutrient water occurs. The source of this water is offshore of the shelf break at depths greater than 100 m. In addition to enriching this slope region it appears, on the basis of temperature, salinity and gradients in nitrogen:phosphorus ratios, that an onshore cross-current transfer may enrich this shelf. This mechanism is consistent with an alternative hypothesis of general shelf enrichment originally proposed by Riley (1967).

An investigation of short-term estuarine variability (ECOVARIATE) is in progress in the St Lawrence Estuary including intensive studies on plankton (Université Laval). Stations are occupied for 175 hours and sampled continuously at 3 depths. Research on primary production is conducted with regard to the influence of light quality and intensity on hourly variabilities. Phytoplankton species are studied

on similar time intervals. Zooplankton species are also sampled to produce time series, their ATP content being monitored to investigate the importance of local production compared to passive transport of dead material.

Spatial patterns of abundance of zooplankton and phytoplankton in surface waters have been determined in the North Sea, the Mediterranean and the Northwest Atlantic using an electronic zooplankton counting instrument together with devices to measure chlorophyll (by fluorescence) and temperature (Dalhousie University). Data from the North Sea in April indicate strong negative coherence between zooplankton and phytoplankton over most spatial scales examined (100m to 50 km). Data from the Mediterranean taken as well during spring conditions, but where biomass of both phytoplankton and zooplankton were much lower, revealed positive coherence of these same spatial scales : data from Georges Bank, taken in August also revealed positive coherences. Power spectra of these variables indicate that zooplankton abundance is more variable at all spatial scales than is either temperatue or phytoplankton abundance.

Laboratory experiments designed to examine behavioural responses (primarily vertical migration) of copepods, as influenced by food concentrations are being carried out to examine the implications of these field studies.

The development of a new multiple net zooplnakton sampler that measures temperature, salinity, net depth, speed and net flow in situ has been developed (Marine Ecology Laboratory). This sampler, used in conjunction with high frequency sonar and echo integration programmes has allowed zooplankton sampling to advance to a level of certainty previously unattainable. Preliminary results suggest that conventional nets may have underestimated the numbers of large euphausiids and similar sized animals by one or two orders of magnitude.

Denmark

(E. Smidt)

West Greenland Waters

Routine sampling with stramin net (2 m ring diameter, ½ hour oblique hauls from about 50 m depth) was made on 4 east-west standard sections in the Davis Strait in July, primarily for estimating numbers of cod larvae. Further, sampling was made throughout the year in the entrance of Godthåb Fjord. Fish eggs and larvae and invertebrates were sorted and counted.

Danish Home Waters

No field work except studies on eggs of cod and sprat in the Bornholm Basin.

Finland

(A. Niemi)

Institute of Marine Research, Helsinki

Because of the reconstruction of RV "Aranda", no open sea investigations were carried out this year.

Phytoplankton primary production (^{14}C, in situ), hydrography and hydrochemistry were studied at the coastal stations Tvärminne and Kopparnäs in the Gulf of Finland. Samples were collected every second or third week during the ice-eriod more sporadically.

Zooplankton sampling (Hensen net, mesh size 150 µm, vertical haul 25-0 m) has been continued at the following coastal stations: Orrengrund (mid-part of the Gulf of Finland, 1967-), Tvärminne (entrance to the Gulf of Finland, 1966-), Seili in the Archipelago Sea (1966-), and Krunnit in the Bothnian Bay (1966-). Samples were taken three times a month (once a month during the ice-period).

Institute of Radiation Protection, Helsinki

Phytoplankton and primary production studies (^{14}C *in situ*) were performed once or twice a month during the ice-free period, around the locality of the nuclear power plants in the Loviisa archipelago in the Gulf of Finland, and in the Rauma archipelago in the Bothnian Sea.

National Board of Waters, Water Research Office, Helsinki

Phytoplankton primary production and physico-chemical parameters were measured in August, at about 30 coastal stations in the Gulf of Finland and the Gulf of Bothnia. Special investigations were performed off several residential areas.

Helsinki Water Conservation Laboratory

Phytoplankton and primary production (^{14}C *in situ* and *in vitro*) were studied twice a month during the ice-free period in the eutrophied waters off Helsinki and Espoo at several stations, from the severely polluted inner bays to the unpolluted area outside the archipelago. Environmental parameters were studied bi-monthly at about 50 stations.

Tvärminne Zoological Station

Bacterioplankton was sampled at approximately weekly intervals thoroughout the year. Quantitative estimates were made by direct counts and plate counts. Quantitative estimates of different physiological types of bacteria were included. The aim of the study was to clarify the seasonal changes of different microbiological parameters in an unpolluted coastal area.

Åbo Akademy, Turku

Primary production and phyto- and zooplankton were studied in semi-enclosed meromictic bays in the Åland Archipelago.

University of Turku

Zooplankton was sampled in the Archipelago Sea for analysis of the PCB-group components.

University of Oulu

Zooplankton investigations were performed in the sea area of the NE Bothnian Bay twice a month from May to November.

France
(S. Arbault)

Travaux de l'Institut des Pêches maritimes

Ichtyoplancton

1) Etude des campagnes d'ichthyoplancton de 1975 dans le Golfe de Gascogne pour les clupéidés

Le but de ces prélèvements saisonnières était de permettre une exploitation quantitative des oeufs et larves de clupéidés afin de déterminer un stock annuel d'oeufs pondus par ces espèces. Les campagnes de mars et mai sont actuellement dépouillées :

- En mars, deux frayères sont bien distinctes :
  - la première est localisée dans la partie méridionale du golfe;
  - la seconde se situe principalement le long des côtes de l'embouchure de la Loire à la pointe de Penmarc'h

Au cours de la campagne de mars 1975 le nombre total d'oeufs estimé sur ces deux secteurs est de $1{,}17624814 \times 10^{12}$. Les larves sont au nombre de $6{,}051000493 \times 10^{11}$, leur répartition est très vaste, elle couvre la presque totalité du plateau continental.

- En mai, le secteur prospecté s'étendait de l'embouchure de la Loire à la Gironde. La frayère accolée aux côtes vendéennes est présente. La quantité de larves est plus importante que les années précédentes.

2) Traitement du fichier des oeufs et larves de clupéidés et engraulidés de 1969 à 1973

Plus de 15 000 données ont été stockées. Plusieurs programmes ont été envisagés afin de mettre en évidence des relations entre différents facteurs au cours de 4 ans de prospection. Les résultats finaux sont en cours de traitement.

Zooplancton

Afin de tenter d'établir des relations entre la présence des mysidacés et euphausiacés et la distribution des jeunes merluchons du golfe de Gascogne, un inventaire systématique de ce trophoplancton a été entrepris.

Actuellement, deux campagnes sont effectuées. Celle de 1975 a permis l'inventaire de 80 échantillons planctoniques et a montré l'abondance des mysidacés au niveau de la "grande vasière". La campagne de 1976, qui comporte 160 pêches, est en cours de dépouillement.

Travaux du Laboratoire de Biologie Animale

Copépodes de la côte atlantique du Maroc (suite). Relation avec les données récentes obtenues dans le secteur sur la production primaire (M.-L. Furnestin).

Zooplancton et micronecton de la Province atlanto-méditerranéenne: synthèse des observations sous les aspects taxonomiques, biologiques et biogéographiques (J.P. Casanova).

Ultrastructure de l'oeil chez les Chaetognathes (Sagitta eukrohnia), suite : incidences biologiques, biogéographiques et phylogénétiques (F. Ducret).

Application de méthodologies nouvelles

Organisation d'un réseau de recherches en microscopie électronique (transmission et réflexion) sur des organismes planctoniques, à des fins biologiques et écophysiologiques.

Tests cytochimiques pour l'étude du fonctionnement des cellules digestives de copépodes nourris en milieu expérimental (J. Arnaud, M. Brunet et J. Mazza).

Germany, Federal Republic of

(G. Hempel)

Biologische Anstalt Helgoland

Routine investigations in measuring hydrographical, chemical and biological parameters at Helgoland Roads were continued. Five times a week temperature, salinity, nutrients (PO_4, NO_3, NO_2, SiO_2) chlorophyll and phytoplankton (inverted microscope) were measured. Furtner weekly determinations were made of the bacterial numbers (pour plate method) in the surface film and at a depth of 1 m, the BOD and the surface tension. The studies on the distribution and ecology of Noctiluca miliaris were continued.

During November, biological and hydrographical parameters have been measured on a one week cruise in the German Bight.

In the Fladen Ground area the primary production, the phytoplankton and the zooplankton have been investigated during the spring bloom (FLEX 76). In the Waddensea of Sylt (German Bight) observations of hydrography (t, S) and inorganic micro-nutrients as well as seston components were continued. Phytoplankton and zooplankton (especially copepods and their larval stages) were examined qualitatively and quantitatively. The suspended particle size spectrum was assessed using the Coulter Counter.

At a four weeks' cruise from Helgoland to about 69°N with the RV "Friedrich Heincke", the distribution of hydrocarbons (including tar-balls of the Neuston) was determined in the waters and sediments at 68 stations. In addition to this the following parameters were determined: Oil-degrading, psychrophilic- and other heterotrophic bacteria, yeasts (including yeasts of seabirds) fungi, planctonorganisms, ATP, primary production, protein content, inorganic nutrients, salinity and temperature. The investigations included besides microorganisms and hydrocarbons the determination of CONS, grain size distribution and meiofauna.

Institut für Meereskunde, Kiel

Phytoplankton and micro-zooplankton

A preliminary survey on the feeding conditions for newly hatched herring larvae in the inner Kiel Fjord, a spawning ground for Baltic spring herring, was carried out by comparing fish larvae and zooplankton abundance at different depths.

Within the framework of pollution studies supported by the Ministry Research and Technology, the regional distribution of PO_4 was recorded along the 6 m depth line in the Kiel Bight during different seasons to measure the influence of municipal pollution. In spite of high PO_4 concentrations, a relatively low value of 190 g C m^{-2} y^{-1} was recorded for the inner Kiel Fjord. An experimental *in situ* study with 400 l plastic bags on the influence of secondarily treated municipal sewage on natural phytoplankton populations with special emphasis on the P-budget was completed. 0.5% sewage accelerated the growth of the natural species assemblage immediately, while an addition of 2% sewage was accompanied by a lag phase of some days' duration with a subsequent change in species composition.

Planktological work within the Joint Research Programme SFB 95 'Interaction Sea - Sea Bottom' of Kiel University concentrated mainly on the sedimentation processes of plankton and particulate matter, with special attention being paid to short-term variations. A complete annual cycle of sedimentation in the Kiel Bight was recorded by means of newly constructed sediment traps. Results obtained from the joint oceanographic/biological expedition 'Baltic 75' indicate that about a third (7 g C m^{-2}) of the organic substances produced during the spring bloom in the Bornholm Sea reaches the bottom (60-80m). Up to 25% of the particulate carbon sinking out of the water column consisted of phytoplankton cells and copepod carcasses. Different time sequences in sedimentation rates were evident at stations hydrographically distinct from each other. At one station 70% of the total organic matter collected sedimented evenly over a period of 18 days whereas at another station 50% sedimented within 6 days. The large numbers of copepods collected in the sediment traps may be due to the probable paucity of zooplankton carnivores in the water column at this season. The analysis of plastic bag experiments at the plankton tower was continued and the first results published (Mar. Biol. 34, Kieler Meeresforschung, Sonderheft 3). The flushing of sediment pore water by density displacement in the course of salinity fluctuation in the bottom water - a characteristic feature in the Western Baltic - was recognised as an important process for the fresh supply of nutrients to the water column, leading to intermittent plankton blooms during summer and autumn.

Upwelling research was centered on two topics. The first one, working up data collected during former expeditions to NW Africa on primary productivity, phytoplankton, zooplankton and detritus standing stock in relation to hydrographic and chemical data, is in progress. Special emphasis is laid on the abundance and biomass of primary and secondary producers in different size groups. The second topic on feeding habits and nutrition of herbivorous copepods is mainly concerned with experimental work. Feeding experiments were carried out with the aid of radioactive tracers to investigate food selectivity, especially dependence on particle size. As a preliminary result, it was observed that *Temora longicornis* is apparently able to feed on the relatively large cells of *Ceratium horridum*. Studies of nutrition problems and food relationships, e.g., a preference for herbivorous or carnivorous feeding by the measurement of enzyme activity were extended after a visit to Dr Boucher's and Dr Samain's laboratory at the Centre Océanologique de Bretagne in Brest (France). First results were obtained with *Calanus helgolandicus*. Feeding after a starvation period resulted first in a drop in amylase and trypsin activity followed by a slow increase, showing that enzyme production evidently relies on an adaption process.

Fish eggs and larvae and other macroplankton

The distribution of macro-zooplankton, particularly krill, (Euphausia superba) was studied in the Atlantic sector of the Antarctic from November 1975 through April 1976. Scotia Sea, Bransfields Straits and the waters around South Georgia were the major areas of investigation. At a four days time station, studies were carried out on the vertical distribution of adult and juvenile krill and of krill larvae. The British RMT 8 + 1 nets and neuston nets were mainly used. The geographical distribution of ichthyoplankton was recorded in the same areas. A brief review of the results will be presented at the 1977 Council Meeting.

The upwelling area off NW-Africa was not visited in 1976. But the material collected during earlier cruises was analysed. Sorting and taxonomical identification of macro-zooplankton, including ichthyoplankton, were continued. The distribution and abundance of fish eggs and larvae as well as euphausiids in relation to water masses was studied in some detail. Plankton biomass taken simultaneously with nets of four different mesh sizes (50-500 microns) has been analysed. Stomachs of larvae of Sardina pilchardus and Engraulis encrasicholus were inspected for food composition.

Two cruises of the RV "Anton Dohrn" (2 February to 24 March and 27 October to 21 December) to the Georges Bank area were partly devoted to the collection of ichtyoplankton, mainly herring larvae.

Another larval herring survey was carried out from 2-14 September in the Shetland-Orkney area of the northern North Sea. At the same time it was tried to assess the importance of predation by herring and sprat on fish eggs and larvae by means of gut contents analysis.

Studies on spawning of cod egg abundance in the Baltic sea (Bornholm Basin) were intensified in cooperation with Denmark.

Discrepancies between results from stock assessment and egg surveys suggest a very high initial mortality of cod eggs.

From March onwards, monthly surveys on fish eggs and larvae have been carried out along the coast line of the western Baltic in order to assess spawning intensity and annual cycles of spawning in near shore areas.

The problem of growth and mortality of herring larvae and the importance of food composition and abundance was tackled by an intermediate approach between field studies and laboratory experiments. A respective programme using 6 m^3 plastic bags anchored in Departure Bay (Nanaimo) was started within the frame of the German-Canadian agreement of scientific cooperation. Analysis of data and material gathered during first experiments carried out in spring at Nanaimo, Vancouver Island, are under way at present.

Iceland

(I. Halgrímsson)

Phytoplankton (Thórunn Thórdardóttir)

Phytoplankton investigations in Icelandic waters were performed in similar ways as before. Productivity was measured with the ^{14}C technique on samples

from standard depths (0, 10, 20 and 30 m), and all samples were illuminated with the same light intensity (ca 9500 lux). Samples for quantitative analysis of phytoplankton were collected at each level where productivity was measured and net plankton hauls taken from the surface at most stations. Chlorophyll a was measured in 1 litre samples, usually from 10 m depth but sometimes from the surface also. Secchi disc readings were made when possible.

Dr John Calkins from the University of Kentucky measured light penetration in the western part of the area surveyed in May-June, with main emphasis on ultra-violet light.

From 27 April to 13 May productivity measurements were carried out at 47 stations in the waters south and west of Iceland, from Breidamerkurdjúp to Snæfellsnes. Eighteen stations were worked twice during the period (Háfadjúp, Selvogsbanki and Reykjanes).

From 26 May to 13 June the traditional spring survey was made in coastal as well as in adjacent deep waters all around Iceland (111 stations). Selvogsbanki was worked in the beginning and at the end of the survey.

On 4 July these same stations (Selvogsbanki) were worked once more together with the Háfadjúp section (9 stations).

In 0-group surveys during 8-26 August measurements were made at 75 of the stations worked in May-June; the oceanic waters off the north and east coasts were not included in this survey.

Finally, measurements were made in Skerjafjördur at 4 stations on 23 January and at 21 station on 5-6 May.

These investigations are part of a more extensive programme in the nearshore area around Reykjavik where the environmental conditions and animal and plant life are being studied. These investigations were initiated because of a planned reorganisation of the sewage outlets in the Reykjavik area.

Zooplankton (Ingvar Hallgrímsson)

In 1976 zooplankton sampling was carried out at 371 stations in the following surveys :

During 24 April to 5 May 87 stations were worked in the Greenland Sea and south and southwest off Iceland. During the period of 8 - 18 May 72 stations were worked in the Greenland Sea and east Greenland waters and during the period of 26 May to 15 June 112 stations in the waters around Iceland.

Sampling in these three surveys was carried out with a Hensen net and Icelandic High Speed Sampler.

From 27 April to 14 May 35 stations were worked off the southwest, south and southeast coast of Iceland with a fine mesh plankton net and a Gulf III sampler.

From 10 to 17 June zooplankton sampling was carried out at 65 stations in the fjords on the northwest coast with a Gulf III sampler.

As previously, the Continuous Plankton Surveys between Reykjavik and New York and Reykjavik Sule Skerry were undertaken in cooperation with the Institute for Marine Environmental Research, Plymouth.

Ireland

(F.A. Gibson)

Nothing to report this year.

Netherlands

(P. Korringa)

Netherlands Institute for Fishery Investigations

During 1976 phytoplankton investigations have been continued in a 70 km wide area along the coast of the Netherlands. For diatoms and dinoflagellates diversity indices have been calculated. The results compared with salinities (representing the river influx) revealed that increasing "enrichment" need not necessarily lead to a reduced diversity pattern. Dinoflagellates suspected to cause toxicity in shellfish were observed in midsummer, but Gonyaulax spinifera did not result in toxicity of the cultivated shellfish.

Protoperidinum trochoïdeum was conspicuous in July, when 12 000 cells/litre, including cysts, were counted. Maximal amounts of the ubiquitous Prorocentrum micans were recorded in September, viz. 25 000 cells/litre, whereas Dinophysis sp. showed 44 000 cells/litre. Outbursts of Prorocentrum redfieldi did not repeat in the year 1976. 15 000 cells/litre was the maximum enumerated. Prorocentrum minimum reached a level of 35 000 cells/litre.

During the month of October, Waddensea mussels caused gastro-intestinal complaints of consumers. Phytoplankton investigations in digest systems of the mussels revealed the presence of Prorocentrum micans.

Netherlands Institute for Sea Research

Theoretical consideration of the whole system of nutrients, phytoplankton, detritus and heterotrophs in the Southern Bight of the North Sea have led to a few plankton models and an ecosystem model. With these models it is possible to simulate production and mineralisation processes in the course of a year. There is a reasonable agreement between fluctuations of C, N, P and Si within the system generated by the models and the fluctuations observed in the field.

Zooplankton samples collected in 1973 and 1974 have been prepared for computer analysis. Programmes written for multiple regression analysis, multiple response analysis, factor analysis and cluster analysis will make it possible to interprete the distribution of most species in terms of encironmental conditions and of production.

Thin-layer chromatographic techniques were developed in order to quantify the various pathways of chlorophyll degradation. Results obtained during the international FLEX-76 programme confirm the usefulness of such methods. A study was made of plankton material collected during the Continuous Plankton Recorder Survey of the British Institute for Marine Environmental Research. The purpose was to determine the natural variability in the plankton of the North Sea and to compare the plankton changes in Dutch coastal waters since World War II with changes in adjacent sea areas that are less influenced by man-made eutrophication.

Norway

(G. Berge & F. Beyer)

1. Institute of Marine Research, Bergen

1.1 Phytoplankton

1.1.1 The long-term monitoring of primary production and standing stocks of phytoplankton over the coastal banks off western Norway continued. An expanded programme covering the entire production season was run covering the area north of N 62° to Vesterålen and the results were combined with the previous material in a study of the annual primary production and its fluctuations. The study constitutes a component of a biological baseline study preceding a planned oil exploitation programme on the shelf. The following parameters were measured: primary production rates (as chlorophyll a), zooplankton taxa and biomasses, light extinction, particle size frequency, hydrography and nutrients. Turbidity and chlorophyll in vivo fluorescence were continuously recorded at 5 m level. The yearly primary production within the area varied between 50 and 90 gC m^2.

1.1.2 The baseline study undertaken in 1975 over the Continental shelf off Northern Norway (Troms-Finnmark) was followed up by a monitoring programme covering all elements in the completed baseline study. Data were collected at three cruises, in May, June and October respectively. The results will be reported at the end of 1977.

1.1.3 As part of the "Joint Norwegian Coastal Current Project" sponsored by the Norwegian Oceanographic Committee, investigation on the spatial and temporal changes of biological parameters was made at two localities off the Norwegian coast, one at Møre (62°38'N 19°36'E) and another at Fugløybanken off Troms (71°04'N 19°36'E). The same parameters as in the two above-mentioned programmes were observed plus continuous analysis of particles vertical distribution.

1.1.4 A long-term programme on environmental conditions in the Norwegian fjords was continued. About 30 fjords along the whole Norwegian coast were surveyed in November-December and samples for analysis of nutrients, oxygen, salinity, temperature, chlorophyll a and particle size frequency were obtained.

1.1.5 Continuous and simultaneous measurements of water transparency and chlorophyll in vivo were carried out during the production season on all the Institute's cruises. The obtained results confirmed the usefulness of the relationship between the two parameters to identify and roughly quantify the presence of non-planktonic particles affecting the transparency of the waters. A preliminary analysis of the relationship between the chlorophyll in vivo fluorescence and the production capacity showed a fairly good correlation over a wide range of values suggesting the possibility of using fluorescence readings as a measurement of primary production. A detailed study on this particular use of in vivo fluorescence measurements is being carried out.

1.1.6 Flødevigen. In connection with the planning of thermic power stations, the baseline studies of phytoplankton, zooplankton and fish productivity in the Oslofjord and adjacent coastal waters continued. During the year, 7 surveys of the area were made. The results were published in Fisken og Havet, serie A, and in a report to the Norwegian authority of water ways and electric power (Institute of Mar. Res., Biological Station, Flødevigen).

1.2 Zooplankton

1.2.1 Sampling was continued at the permanent oceanographic stations along the coast of Norway, at West Spitsbergen and at station Mike in the Norwegian Sea. The working up of the material is in progress.

1.2.2 In the Norwegian Coastal Current Project zooplankton was sampled in five sections along the coast of Norway. Vertical hauls 20 - 0 m and 100 - 0 m were taken with Juday nets (J. 36 mesh 180 µ). At Svinøy north of Cape Stad short time variations in zooplankton were studied during May, the section being repeated seven times. In addition, plankton hauls were taken at two-hour intervals at two diurnal stations, and horizontal hauls with Clarke-Bumpus plankton samplers were taken at four different levels. The Svinøy section was also covered in April, August and October.

The other sections were repeated from two to four times between March and November. In all, 350 stations with plankton hauls were taken

1.2.3 In baseline investigations for the oil prospecting programme off northern Norway, zooplankton was sampled from the weather ship "Ami" in vertical hauls with Juday nets at a fixed position, 71°30'N lat, 19°00'E long. once a week from the beginning of September. Plankton material are worked up by methods described in previous reports.

1.2.4 Investigations related to commercial exploitation of zooplankton (Calanus) continued. Off Berge, the spring plankton was scanty in May, not more than 10-20 ml/m^2. Experimental fishery with trawls and anchored nets was less successful than in 1975, only five metric tons being caught during May, compared with 13 tons in 1975. The development of the zooplankton was evidently delayed for three weeks.

Off northern Norway large quantities of Ctenophores preyed on the zooplankton during June.

1.2.5 At an aquaculture station in the Masfjord north of Bergen, relatively large quantities of Calanus, maximum 14 kg per 1000 tons of water, were taken from the seawater pump inlet during May and June. The concentration of plankton at the inlet of the pump at 5 m level, was evidently caused by the combination of an upper layer of freshwater and a strong ingoing current in the deeper layers.

1.2.6 Krill (Euphausiids). In March, experimental fishery for krill was carried out with hand ketchers and lights in a fjord south of Bergen. Meganyctiphanes norvegica was attracted in great quantities. During one night, three men caught 1 000 kg of krill. Trawling for krill was not successful.

2. University of Bergen - Biological Station, Espegrend

2.1 Field studies were carried out in a small land-locked fjord, Fauskangerpollen, to determine the level of primary production in spring and summer, the occurrence and composition of the meroplankton, and the diurnal vertical migration of zooplankton in relation to grazing.

2.2 In conjunction with the Norwegian coastal current project, repeated zooplankton surveys were made of a section along 59°20'N from the Norwegian coast to about 2°E, in order to make stock estimates between March and May, at the time when detailed current measurements were being made. Also in conjunction with the same project, intensive studies were made of a section N.W. from Svinøy off the coast of Møre, with the special intent of investigating short-term variability and the repeatability of sampling.

2.3 Modelling of the land-locked marine ecosystem in Lindåspollene has continued, in which the estimated production of phytoplankton and zooplankton occupy central positions.

2.4 Experimental studies have included bioassay experiments on nutrient limitation, feeding and starvation effects on carnivores, and estimates of their assimilation. The information on carnivores is being included in a description of the bathypelagic community in Korsfjorden, whose vertical structure was also studied further in 1976.

2.5 Samples from Ryfylke fjords continue to be analysed with the aim of recording the plankton community before water run-off is affected by a hydro-electric scheme.

3. Norwegian Institute for Water Research (NIVA), Oslo

3.1 Phytoplankton

3.1.1 Eutrophication effects in the Oslofjord were studied by means of chlorophyll measurements and cell counts from quantitative samples.

3.1.2 Growth potential experiemnts were carried out in the laboratory for the same purpose.

3.1.3 Sampling was carried out in Frierfjorden and Borgundfjorden.

4. University of Oslo, Institute of Marine Biology and Limnology

4.1 Phytoplankton

4.1.1 Surveys

4.1.1.1 The investigation of the spring phytoplankton in the spawning areas of cod and herring (Lofoten to Møre) was continued in collaboration with the Marine Research Institute of the Fisheries Directorate in Bergen. This investigation is part of the Norwegian IBP/PM programme. (I. Nygaard, T. Braarud).

4.1.1.2 Phytoplankton was examined as part of oceanographic surveys carried out in coneection with the hydroelectric power plant projects. A survey in the Ryfylke Fjords, is in progress (I. Nygaard, T. Braarud).

4.1.1.3 A report on the summer and autumn phytoplankton of Nordåsvatn, a land-locked fjord near Bergen, is in preparation (K. Tangen).

4.1.2 Special Studies

4.1.2.1 Taxonomic studies on coccolithoporids, by means of transmission and scanning electron microscopy, were continued (K.R. Gaarder).

4.1.2.2 Morphology, taxonomy, and distribution of marine plankton diatoms were studied by means of light and electron microscopes (G. R. Hasle).

4.1.2.3 Influence of growth conditions on diatom furstule morphology was investigated (E. Syvertsen).

4.1.2.4 Experiments were initiated to study the nutrient status of Oslofjord phytoplankton as evaluated by various physiological and biochemical criteria (E. Paasche, students).

4.1.2.5 Experiments were carried out on the suitability of water in the inner Oslofjord as a growth medium for representative plankton algae (E. Paasche).

4.1.2.6 A report on dinoflagellate mass occurrence associate with fish kills along the Norwegian west coast is in preparation (K. Tangen).

4.1.2.7 Taxonomy and morphology of dinoflagellates were studied by means of light and scanning electron microscopes (J. Throndsen, B. Dale, K. Tangen).

4.1.2.8 Smaller field investigations were carried out on phytoplankton composition and distribution at several inshore localities in southern Norway, outside the Oslofjord area (students, staff).

Programme for 1977

Investigations mentioned above (4.1.1.2; 4.1.1.3; 4.1.2.1-4.1.2.5 and 4.1.2.7) will be continued.

4.2 Zooplankton

4.2.1 Local studies of quantitative composition of zoo-neuston, zoo-hyponeuston and zooplankton continued in the Oslofjord (T. Schran).

4.2.2 Diurnal changes in the relation between zooplankton and hyperbenthos were studied over soft bottoms of various depths in the Oslofjord (F. Beyer).

4.2.3 Studies were commenced on the relation between diurnal vertical migration of zooplankton and the hydrographic discontinuity layer in the Oslofjord (F. Beyer).

4.2.4 Studies were commenced on the dependence of zooplankton species in the inner Oslofjord on recruitment from outside.

5. University of Tromsø

5.1 Phytoplankton

Institute of Biology and Geology, and Marine Biological Station.

5.1.1 Studies are being carried out on phytoplankton species composition in Balsfjord, with special emphasis on the seasonal succession in the upper 50 m as part of the University of Tromsø's "Fjord Project". In addition, measurements are being made of chlorophyll concentration using a Turner

fluorometer coupled to a variable depth water pumping system. Information if also being collected on ^{14}C uptake, temperature, salinity, particulate carbon and nitrogen, dissolved oxygen, phosphate and nitrate, as well as levels (quanta) of solar radiation. and underwater irradiance. This work is being carried out in close cooperation with a zooplankton study.

5.2 Zooplankton

Institute of Biology and Geology

5.2.1 In March 1976, zooplankton production investigations were initiated in Balsfjord as part of the integrated "Fjord project". This work on the dominant species in the zooplankton is designed to elucidate topics such as the life cycle and life span of organisms, species diversity in relation to environmental factors, vertical migrations, growth and reproduction, abundance and distribution of predator and prey, and the relation between events in the zooplankton and the timing of the seasonal cycle of the phytoplankton. Of particular importance is the investigation of basic biochemical body components (e.g., lipid, protein, C:N ratios) and calorific value in an effort to examine such features as trophic inter-relationships and over-wintering condition in these northern latitudes. Areas of zooplankton productivity are being mapped and sound scattering layers are being examined with the aid of Simrad EK 120 and EK 38 echosounder systems.

6. University of Trondheim, Biological Station and the Institute of Marine Biochemistry

6.1 Phytoplankton

6.1.1 Biochemical and biological studies of the phytoplankton were carried out in the coastal current off Möre and in the Trondheimsfjord (Sakshaug & Myklestad).

6.1.2 The chemical composition of Emiliana huxleyi was studied as a function of the composition of the medium (E. Sakshaug).

6.1.3 Carbohydrate production and metabolism of marine phytoplankton, especially diatoms, were studied in relation to environmental conditions, particularly nutrients (S. Myklestad).

6.1.4 Investigations were carried out on the use of dialysis culture for measuring growth of phytoplankton in the field (A. Jensen).

6.2 Zooplankton

6.2.1 Biochemical and biological studies of the zooplankton were carried out in the coastal current off Möre and in the Trondheimsfjord (Sakshaug and Myklestad).

Poland

No report received.

Portugal

(T. Neto & G. Vilarinho)

In March 1976 we started a programme on collecting samples from a private fishpond to determine the water quality and to study the bacteria and the qualitative and quantitative plankton and its evolution. The fishpond is on the right-hand side of the Sado estuary and does not receive artificial food, but only the river water which comes in by sluice gates opened once a month on the highest tide (M.H. Vilela, M.A. Sampaio).

Studies included in the programme of monitoring of the coast of Sines and Lagoa de Sto André were the following : Qualitative and quantitative studies of phyto- and zooplankton, determination of diversity index, determination of indicator species (J. Calejo Monteiro, C. Mota, L. Fernandes, J.C. Mateus).

Studies were also carried out on zooplankton, mainly copepods and siphonophora, collected by the RV "G.O. Sars" SW of Portugal and the Azores during November/December 1975 with a Juday net. (I. de Paiva, T. Neto).

Spain

(J. Corral & M. Durán)

Instituto de Investigaciones Pesqueras

Phytoplankton

The work on "Studies on aquatic populations in a not-uniform medium" has been completed.

The study on fluorescence properties of the photosynthetic system, considering it as a union between semi-conductors, has been continued. The main purpose is a theoretical and experimental study of light conversion into electric energy by metal-chlorophyll pigment cells. The title of the study is "Chlorophyll systems of energy transformation".

Zooplankton

The structure of autumn zooplankton populations off Cabo Blanco (NW Africa) was studied.

An ecological study of neritic zooplankton off Punta Endata (Bilbao) has been undertaken.

A statistical study was made of several zooplankton samplers, as well as an analysis of the correlation between males and females, and population dynamics in the genus Acartia.

A study on the "Influence of light, temperature and particulate organic matter on metabolic activity and feeding of planktonic copepods" has been completed.

The study of zooplankton populations in relation to water masses in the West Mediterranean has been started.

Ichthyoplankton studies on the west coast of Africa, including eggs and larvae of Clupeidae, Engraulidae and flatfishes has been continued.

Instituto Español de Oceanografía

Phytoplankton

A study of the phytoplankton on the Ria de Arosa (Galicia) has been continued. This area has a well developed mussel culture and the studies were carried out in relation to environmental parameters and compared to other areas such as the Ria de Muros, which is without a mussel culture.

A paper on the correlation between phytoplankton in the gut of mussels and in waters surrounding mussel rafts has been completed.

Phytoplankton caught near the Ebro River mouth was studied.

Zooplankton

The main objective of the study on zooplankton on Rias de Galicia is to know the zooplankton in relation to food chains in the Ria. For that purpose studies are carried out on the composition and structure of the community throughout the annual cycle, the relation of species to environmental factors, biomass throughout the cycle, expressed as dry weight, ash-free dry weight, carbon and nitrogen content and caloric content per cubic metre. At present, the same study has been started on Ria de Muros, as well as cultures of copepods and chaetognaths to determine the rates of feeding and excretion.

Bacterioplankton

Planktonic bacteria in Ria de Arosa have been studied with determination of species and heterotrophic uptake of ^{14}C glucose.

Ichthyoplankton

During 1976, the group working in this field has been dealing with the following subjects :

1) As part of a previous study to estimate the biomass of the adult spawning population of sardines (S. pilchardus) of the Cantabrian Sea, we studied the samples collected in "Itxaso I" to determine the distribution and abundance of the pelagic eggs.

2) We have also studied the samples collected during a 1975 cruise through the western Mediterranean, to locate spawning areas for bluefin tuna, frigate mackerel, albacore, skipjack and little tuna. A preliminary evaluation of the spawning stock of bluefin tuna has also been accomplished.

3) From the samples collected in the 1975 cruise, we are also studying spawning distribution of other fish groups.

4) Finally, in the NW region of Spain we are studying the distribution and abundance of hake and poutassou larvae, and in the Alboran Sea the anchovy larvae.

Sweden

(A. Lindquist)

Baltic and Gulf of Bothnia

The intensive investigations on plankton which started in 1968 were more

or less terminated during the year. All the material was worked up and a number of publications have been prepared. The investigations included phytoplankton, zooplankton and primary production and the main interest has been to study changes in productivity, if observable.

Methodological studies resulted in a Manual prepared by the Baltic Marine Biologists.

The occurrence of fish eggs and larvae has been studied in detail, both close to the coast and in open waters. Experiments have been made with pelagic eggs.

Skagerrak, Kattegat

Phyto- and zooplankton samples have been taken between Gothenburg and Frederikshavn. Analysis of the material has commenced. Together with plankton sampling intensive work has been carried out on nutrients, etc. In fact, the biological programme was from the beginning only a part of a joint Danish/Swedish study of the situation in the Kattegat.

Herring larvae and other ichthyoplankton has been collected with an IKMWT and a Bongo net in different expeditions. Elvers have been collected during the ichthyoplankton investigations.

United Kingdom

1. England and Wales

(D. Harding)

The Lowestoft Plankton Surveys

In 1976 the bulk of the plankton work was directed to the west central North Sea between the east coast of England and 2°E, and the north Norfolk coast and 56°N. Twelve plankton surveys were carried out in this area between January and December 1976, with the main objective being to describe the distribution, abundance, mortality and drift of the eggs and larvae of fish spawning in this area. This work was supported by hydrographic observations; which included current measurements, sea bed drifter releases, temperature, salinity and nutrient measurements; and phytoplankton and zooplankton studies, which ranged through continuous chlorophyl a measurements using a Turner-Design 10 fluorometer, counts of dinoflagellates, volumetric estimates of zooplankton biomass and neuston sampling for lobster larvae. A resumé of this work will be published in the next edition of Annales Biologiques.

The International Herring Larvae Surveys were also integrated into this series of surveys off the north-east coast of England and the counts of herring larvae from the September and October cruises of RV "Corella" in 1976 have been worked up and were presented to the ICES Herring Working Group in February 1977.

Experimental Work

To support the work at sea, development rates of various planktonic animals have been undertaken at Lowestoft for a number of years. In 1976, Calanus was grown through its life cycle at a range of temperatures and attempts have also been made to culture larval cod and whiting under laboratory conditions with varying degrees of success.

Gear Development

Plankton samplers used in the north-east coast surveys were calibrated in the National Maritime Institute's flume and clogging experiments were carried out using polythene inserts to the net which simulated the type of clogging which occurs at sea.

The refurbished vertical distribution sampler was also tested at sea in 1976. It was fitted with an electric depth gauge with a digital read-out and takes four samples in sequence. Digital gauges were also fitted to the standard plankton samplers to read depths to 0.1 metre and temperature to 0.1°C.

Surface irradiance measurements were made continuously on these surveys using a new quantum deck cell and underwater measurements of total and spectral irradiance were made in quantum units and illuminance with an underwater version of the deck quantum cell and a new scanning spectral photometer. The surface cell has also been tested on Data Buoy 1; a fixed hydrographic and meteorological data station which was moored near Lowestoft for trials in 1976.

AnHIAC particle counter capable of counting and sizing particles in the range of 2-2 500 microns has been under testin the laboratory and at sea in 1976. The unit is being developed for on line use at sea and its standard output has now been linked to a pulse height analyser which allows counts to be sized into a hundred or more categories.

Future work

In 1977 five surveys are to be carried out in the Western Approaches to the English Channel to sample the mackerel spawning between the months of March and July. The results of the egg surveys will be used to obtain an independent estimate of the mackerel stock size. To support this work development rates of the egg stages will be measured using an incubator with a capability of culturing the eggs at a range of twenty temperatures simultaneously.

A survey of cod eggs will be undertaken in the northern sector of the Irish Sea in February 1977 to determine the location of the main cod spawnings.

Patch surveys are proposed for March and August 1977, the former in the Southern Bight will be designed to study biological and physical phenomena in one and two dimensions, the latter in the West Central North Sea will investigate three dimensional effects associated with the thermocline off Flamborough Head.

2. Scotland

(J.A. Adams)

1. Marine Laboratory, Aberdeen (DAFS)

The plankton of inshore waters

Four areas were investigated in 1976, namely the Sound of Raasay and Loch Linnhe-Loch Eil both on the west coast of Scotland, Sullom Voe in the Shetland Islands and the Firth of Forth. These surveys are part of a long-term programme of describing, at least superficially, the plankton populations in Scottish inshore areas where changes in the ecosystem could result from pollution (J.A. Adams, D.D. Seaton).

Scyphomedusae of the North Sea

The sixth survey of the distribution and abundance of the scyphomedusae was conducted during June. Again the other institutes taking part in the international 0-group gadoid survey cooperated in the study. The results will be described in a paper to ICES in 1977 (S.J. Hay, J.A. Adams, J.R.G. Hislop).

FLEX The Laboratory took an active part in the JONSDAP 76 exercise in cooperation with the Institute for Marine Environmental Research (see below), the Fisheries Laboratory Lowestoft, and the Institute of Oceanography, Dalhousie University and the Hamburg University. The joint programme of the laboratories had three main objectives, in terms of data acquisition :

i) To describe the horizontal variability of the physical, chemical and biological processes over the FLEX square throughout the period mid-March to mid-June.

ii) To describe the vertical variability of the physical, chemical and biological processes at stations near the margin at the centre of the FLEX square.

iii) To measure rates of selected processes (e.g., primary productivity, nitrogen production, sedimentation, etc.).

Four cruises were completed by the Laboratory - "Challenger", 18-23 March, "John Murray", 2-25 April, "Cirolana", 2-13 May and "Explorer", 11 May-4 June. Additional data on chlorophyll distributions were obtained on "Planet" (10-31 May) and "Friedrich Heincke" (12-25 May).

Zooplankton feeding and phytoplankton size spectra data were obtained during the "Meteor" cruise. (J.H. Steele and many colleagues).

Simulation models of planktonic ecosystems

Work has continued on the development of a model investigating the influence of vertical processes on the development of plankton populations in time and space (G.T. Evans) as has work on the multispecies phytoplankton-zooplankton model developed by J.H. Steele and B.W. Frost.

Distribution and abundance of fish eggs and larvae

Surveys to determine the distribution and abundance of herring larvae were carried out in the Firth of Clyde in the spring and off the west, north and east coasts of Scotland in the autumn (D.W. McKay).

Ecology of larval gadoids

The study of the ecology of larval gadoids outline in last year's Administrative Report was completed during the year and is now being written up for publication (R.C. Minton, D.V.P. Conway).

The effects of pollutants on the marine ecosystem

Studies of the effects of pollutants on the marine ecosystem were continued using large plastic enclosure in Loch Thunaig, a small bay at the head of Loch Ewe on the west coast of Scotland. Three enclosures were set up about the middle of August "trapping" the water and the natural plankton populations. Two of the enclosures (of which one was the control for the experiment) had a high level of nutrient addition while the third had

a low level. At the end of August mercury at 1 µg/l was added to both the experimental enclosures and after a further 22 days both were dosed with mercury at 10 µg/l. Observation on the quantitative and qualitative changes of the plankton population together with measurements of rates of primary production, microbial activity and zooplankton feeding were continued until the end of October. Material settling to the bottom of the enclosures to which mercury had been added was removed and placed in small chambers where it was in contact with the sea bed. The rates at which the mercury was methylated and resolubilised were then measured (J.M. Davies, J.C. Gamble, G. Topping).

The effects of environmental factors, including pollution, on fish eggs and larvae

Spring spawning herring As in 1975, the development and survival of spring spawned herring eggs and the resulting larvae were studied in water from Ballantrae Bank and Irvine Bay (both in the Firth of Clyde) (I.C. Baxter).

Autumn spawning herring Fertilised eggs of autumn spawning North Sea herring were placed in a large plastic enclosure at Loch Thurnaig and the growth and survival of the larvae which hatched studied. This was a preliminary experiment in preparation for more detailed work in 1977. Towards the end of the study an oil slick, simulating the situation likely to arise from a medium sized oil spill after 5 hours, was floated on top of the water and the resulting mortality measured (I.G. Baxter, N.T. Nicoll).

Sandeels Preliminary work was also done on the egg and larval development of *Ammodytes tobianus* in preparation for an investigation of the effect of cadmium on the development and survival of the eggs and larvae of this species (D. Whitford, D.D. Seaton).

The Biology of *Bolinopsis infundibulum*

A complete year's survey was carried out in Loch Ewe of the population numbers and vertical distribution of this lobate ctenophore. Experimental work was very limited during 1976, but the feeding response in relation to food abundance was measured for two size groups and an opportunity was taken to investigate its feeding on haddock larvae (J.C. Gamble).

The Feeding of *Oithana* spp.

Preliminary work was carried out in preparation for a study of the feeding of *Oithana nana* and *O. similis* (R.S. Lampitt).

Experimental phytoplankton studies related to marine pollution

The work described in last year's report was completed and has now been discontinued.

The programme for 1977

The programme will basically be a continuation of that in 1976, but with increasing effort being directed towards studies of the inter-relationships between 0-group gadoids and zooplankton.

2. Institute for Marine Environmental Research, Edinburgh and Plymouth

The Continuous Plankton Recorder Survey

The survey by the Continuous Plankton Recorder was continued in 1976 on the same basis as in previous years. Recorders were towed at a depth of 10 m at monthly intervals along the standard routes. In addition, two routes were operated by the US National Marine Fisheries Service.

During the past year Recorders were towed for 120 074 miles by 33 ships of 8 nations. The present survey has been in operation since 1948 and since then the plankton has been collected and the results have been processed in exactly the same way. Details of the data processing system are given by Colebrook (Bull. mar. Ecol., 8, 193-242). Measurements of temperature were taken on the K, L, LR, C, IS, IN and PR routes in 1976.

The organisation of the CPR survey was moved from Edinburgh to Plymouth in January. Further details may be obtained on application to the Institute for Marine Environmental Research, Prospect Place, The Hoe, Plymouth PL1 3DH.

FLEX 76 (Fladen Ground Experiment)

The main IMER effort was directed towards analysis of the horizontal and vertical variability in the distribution of the plankton. The horizontal variability was investigated with Continuous Plankton Recorders and Undulating Oceanographic Recorders and the vertical distribution of the plankton by means of Longhurst Hardy Plankton Recorders.

3. Dunstaffnage Marine Research Laboratory (SMBA)

The work done in 1976 was as follows :

1. Completion of the studies of growth of crustaceans.
2. An examination of the integumental glands and sensillae of a wide variety of crustaceans.
3. Studies of integumental organs of pelagic decapods.
4. Completion of the sampling programme and practical work for the study of the biology of Pareuchaeta norvegica inshore and offshore.

In 1977, it is hoped to prepare papers on the above work for publication and complete the examination of integumental sensilla in calanoid copepods.

U.S.A.

(K. Sherman & G.D. Grice)

Ichthyoplankton

Surveys of fish eggs, larvae and zooplankton were continued by the National Marie Fisheries Service (NMFS) in 1976. Standard MARMAP sampling methods using paired bongo samplers were used from the Gulf of Maine to Cape Canaveral. The most intensive surveys were conducted off the northeast coast. In addition to the autumn and spring MARMAP surveys conducted by the Northeast Fisheries Center

(Bay of Fundy to Cape Hatteras) and South Carolina Division of Marine Resources (Onslow Bay, N.C. to Cape Canaveral), a series of monthly ICNAF collections of herring larvae were made from September through February on Georges Bank. The participating countries included the Federal Republic of Germany, Poland, USA and USSR. The 1976 production of larval herring was the lowest observed since annual monitoring was initiated in 1971. Analysis of the abundance, mortality and growth of Georges Bank-Nantucket Shoals herring larvae for the three previous winter periods (Dec.-Feb, 1973-74, 74-75, 75-76) was presented in ICES C.M. Doc. 1976/L:37. An inverse relationship was observed between larval mortality and growth which is believed to be regulated by food supply. Further, it appears that the over-winter period (December to February) may be the time during the larval stages when the mortality rate is critical to year class strength. Processing of larval gut contents and associated fine mesh zooplankton samples (for food organisms) will soon be completed for two winters, and these data should indicate whether larval growth (and subsequent mortality) are related to average density of food.

The Sandy Hook Laboratory (NMFS) completed its 4th year of fall plankton surveys in the Mid-Atlantic Bight. The surveys are conducted to monitor seasonal changes in the distribution and abundance of fish eggs and larvae. Larvae of hakes and Gulf Stream flounder predominated in the northern part of the Bight and croaker at stations in the south.

The impact of the "Argo Merchant" oil spill on the fish and larvae of the Nantucket Shoals area was investigated. Preliminary results indicated that significant amounts of "Argo" oil were ingested by copepods. The effect on the Nantucket Shoals - Georges Bank ecosystem is being investigated.

The MARMAP Field Group at the NMFS Narragansett Laboratory continued monitoring plankton populations on two Continuous Plankton Recorder routes off the northeast coast. They also maintained their monitoring of neuston at 28 locations off southern New England in cooperation with the U.S. Coast Guard.

At the Narragansett Laboratory, Dr G. Laurence is continuing work on the bioenergetics of larval fish survival with a new series of experiments on cod and yellowtail flounder embryos. In cooperation with EPA, Dr W. Kühnhold, visiting scientist from the University of Kiel, conducted experiments on the effects of number 2 and 6 fuel oil on cod embryos. Significant mortalities were observed in cod embryos dosed with 100 to 500 ppb of number 6 oil.

During 1976 the ichthyoplankton effort at the Miami Laboratory of the Southeast Fisheries Center (NMFS) was concerned with the identification of fish larvae collected in earlier years. Studies are concerned principally with changes in the abundance of larval scombrids, istiophorids and panulirids.

The Southwest Fisheries Center in La Jolla (NMFS) continued research on the oceanographic changes that affect the distribution of larval fish food of northern anchovy, jack mackerel, and Pacific sardine; analyses of anchovy mortality rates (1951-69); developing techniques for assessing suitability of water masses as feeding areas for larval fish; studies of larval fish predators; modelling of larval bioenergetics; the use of otoliths in the ageing of anchovy; and the food chain studies of pesticide uptake by larval anchovies. Investigations on the taxonomy, distribution

and abundance of fish larvae is also continuing. Several important studies have been published on : stromateoid fishes, lanternfishes, scorpaenids, and flatfishes. Dr Ahlstrom continued his training of larval fish experts with his 4th annual 4-week MARMAP course on the identification of fish eggs and larvae.

As part of its continuing studies of the economically important eastern Bering Sea fishes, the Northwest and Alaska Fisheries Center (NMFS), Seattle, Washington, is monitoring the temporal and areal distribution and abundance of walleye pollock (Theragra chalcogramma) eggs and larvae and to estimate the size of spawning populations. Ichthyo- and zooplankton were sampled in the eastern Bering Sea in April and May 1976 using standard MARMAP methods. Fifty-six stations were sampled. The most abundant species was the pollock. The total catch of pollock larvae amounted to 61% of the total catch of larvae. Sculpins (Cottidae), sand lance (Ammodytidae), snailfish (Cuclopteridae) and rockfish (Scorpaenidae) were the next most important taxa, totalling 26.3% of the total.

Plankton/Ecology Investigations

Investigations at the Woods Hole Oceanographic Institution (WHOI) continued in 1976 to emphasize studies of the genetic variability of clones of diatom species isolated from neritic and oceanic waters using electrophoresis techniques and silicon uptake by diatoms in relation to light. Population succession and species behaviour is being examined in the Gulf Stream wold core rings. Field observations and laboratory experiments are being conducted on feeding of ctenophores and salps. The species of copepods producing resting eggs and environmental factors influencing their hatching are being investigated.

A major part of the research activity of the Bigelow Laboratory in 1976 was concerned with the physiological ecology of marine phytoplankton. Within this broad area the following specific investigations were continued: studies of carbon assimilation during photosynthesis; the kinetics of nitrogen assimilation; the use of enzymes as a means of measuring rates of assimilation of essential nutrients - notably nitrate reductase for nitrate assimilation and carboxylases for carbon fixation; the use of the electron transport system (ETS) in attempts to measure respiration; the flux of organic carbon compounds in the oceans as revealed by measurements of excretion from phytoplankton and utilisation by the microbial population; and the comparative biochemistry of dinoflagellates and diatoms with particular emphasis on the cause of red-tides. The investigations were undertaken in three major areas of the oceans : seasonal surveys at selected stations off the Maine coast; more extensive surveys in the Gulf of Maine and on Georges Bank; and in subtropical and tropical waters in both oligotrophic and upwelling regions. Against the background of phytoplankton research, the Bigelow Laboratory plans to increase its studies of zooplankton feeding.

During 1976 the Virginia Institute of Marine Science continued adding to its extended series of zooplankton collections from slope waters around Norfolk Canyon. Collections are for the period 1973-1976. They are being sorted for fish larvae by VIMS staff. Six stations off southern New Jersey are sampled seasonally for ichthyoplankton as part of a survey of baseline conditions of the outer continental shelf. Each station is occupied for a 24 hour period., sampled each 3 hours for neuston (1 m 0.505 mm net) and once each quarter with 24 cm closing bongos of both 0.202 and 0.505 mm mesh nets. Studies are under way of neuston communities in this area, their diel cycles and their importance to several commercially important species. The primary technique of analysis

is a cluster of samples and species, utilising the Bray-Curtis coefficient of similarity. Theses and dissertations are under way on decapod larvae, pteropods and pelagic amphipods from these collections. The second year of BLM studies started in November 1976 and VIMS is sampling an expanded number of stations, adding a couple south of Hudson Canyon and 4 along a transect from the eastern shore of Virginia to Norfolk Canyon. Replicate sampling with 24 cm bongos using 0.202 mm and 0.505 mm mesh nets is being conducted quarterly at 3 of our present 12 stations. Nine of these stations are occupied for 24-hour periods.

Plankton research at Duke University Marine Laboratory in 1976 centered on the flux of carbon through planktonic communities. This research included 1) assessments of temporal and spatial heterogeneity in estuarine and coastal phytoplankton species assemblages; 2) studies of primary production and its regulation by secondary growth factors; 3) investigations of the mechanisms by which continental shelf primary production is affected by intrusions of deep water onto the shelf; 4) studies of the feeding behaviour of estuarine, coastal and oceanic copepods; 5) investigations of copepod reproductive strategies. In addition, taxonomic and zoogeographic studies of oceanic radiolaria are under way.

During 1976 research at the Biological Laboratories of Harvard University continued on the nitrogenous nutrition of plankton. The investigations are being conducted in the southern Sargasso and eastern Carribean Seas. Ongoing laboratory experiments are aimed at assessing the physiological responses of marine phytoplankton to transient nitrogenous nutrient deprivation.

The Marine Science Research Center (MSRC) at the State University of New York at Stony Brook is continuing studies of the relationship between zooplankton ingestion rates and spatial heterogeneity in phytoplankton biomass distributions in Long Island Sound. The ability of particle feeding zooplankton to increase their feeding rate rapidly in order to take advantage of the high concentration of food encountered in phytoplankton patches is being investigated. This study is complimentary to an NSF funded investigation of the distribution of phytoplankton patches and their causes in Long Island Sound. Phytoplankton communities are also being studied in large enclosures in a tidal marsh on the north shore of Long Island. 1.5 liter bags of dialysis membrane tubing are being injected with synthetic organo-chlorine compounds. Measurements are made of the changes in the size distribution and species composition of the phytoplankton community, along with rates of growth and photosynthesis. Future studies will include zooplankton, since grazing influences and is influenced by the abundance and size of phytoplankters. Alterations in abundance and size distribution in the phytoplankton community may be reflected in changes in the feeding behaviour and make-up of the zooplankton community. In a joint study with Brookhaven Laboratories, MSRC is studying the biology of plankton communities in the southern New England continental shelf and Peruvian upwelling areas. The MSRC contributions chiefly concern the concentration and types of photosythetic pigments in these areas and factors affecting their distribution.

Plankton research at Chesapeake Bay Institute at Johns Hopkins University during 1976 emphasised both annual and shorter term nutrient cycling in a major estuary. A box model is being used to analyse a large body of nutrient data for inputs and outputs to Chesapeake Bay and to describe nutrient flow within the estuary. The roles of water column and sediment bacteria in nutrient cycling are under investigation, and a study of the

micro-zooplankton contribution to phytoplankton nutrient pools will be undertaken in the near future. These studies are conducted in the field as well as in the laboratory.

U.S.S.R.

(A.F. Karpevich & T.K. Sysojeva)

In the Barents Sea, 342 phytoplankton, 3 100 zooplankton and 520 euphausiid samples were collected in 1976. A quantitative weight analysis of the feeding of 1 451 specimens of cod fry and 1 325 specimens of adult Polar cod was carried out. A determination of the winter euphausiid stock in the Barents Sea was conducted. Some idea of the abundance, distribution and features of species and age composition of the Barents Sea euphausiids in 1976 were gained from the material collected. These data are indicative of the summer food base for gadidae in the Barents Sea. In 1975 the analysis of the spring-summer development of zooplankton in the areas off the northwestern coast of Norway and in the southwestern Barents Sea was carried out. The feeding and biological indexes of the 0-group Barents Sea young cod of the 1975 year class were also investigated. The coefficients of their survival form the first year of life to the third were calculated.

The material collected for many years (1953-1976) on the biology of the abundant species of euphausiids from the Barents Sea which revealed the great role of temperature conditions in the euphausiid population formation was analysed.

The seasonal development of phytoplankton in different water masses of the Barents Sea was also analysed.

Abundance, biomass and bacterioplankton production in shallow and deep water areas of the northern basin, and also the abundance and biomass of bacterioneuston in the near surface layer of the northern seas were determined.

In 1977 the plankton investigations in the Barents Sea will be continued according to the previous programme.

Fish food supply and commercial algae of the Baltic Sea

In accordance with research programmes the following biological material was collected : 1 018 samples of zooplankton, 62 samples of nektobenthos, 195 samples of benthos and 900 fish samples. On the basis of the material the conditions of zooplankton by seasons, depths and areas of the Baltic Sea, the Gulf of Riga and the Gulf of Finland were revealed, the abundance and distribution of nektobenthos (in the Gulf of Riga) and benthos (eastern Baltic) were also studied.

Regularities of vertical distribution of zooplankton by seasons in relation to changes in the hydrographical conditions, food supply and population year cycles were investigated.

Trophic and population composition of zooplankton was studied. Feeding conditions of the Baltic herring in the Baltic Sea and the influence of feeding conditions on its biological parameters were revealed; some aspects of feeding biology of southern Baltic herrings were dealt with.